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UK Construction Supply Chain Attitudes to BIM

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The UK construction industry is facing a challenge to improve productivity. It is argued that this challenge can be met through the adoption of Building Information Modeling (BIM) which would improve efficiency by integrating the sequence of processes and activities encompassing all organizations involved in a construction project. Construction projects operate in an environment that is characterized by fragmentation and uncertainty and the companies that make up the construction supply chain possess dynamic capabilities in order to survive in this operating environment. This research study investigated the nature of the environment that subcontractors in the UK construction supply chains operate in, the aims of BIM solutions and the attitudes of subcontractors in the supply chain of a national UK main contractor to BIM solutions. The study focused on determining the supply chains' views on the key opportunities of BIM and the key challenges involved. The study was performed by surveys carried out with practitioners in subcontracting companies in the supply chain of a national UK main contractor.

Keywords: Building Information Modeling, Supply Chain Management, Dynamic Capabilities.

Introduction

It is almost 20 years since the UK construction industry was called on to improve productivity firstly through a focus on efficiency using improved integration, teamwork and partnerships (Latham, 1994), then through reengineering overall delivery (Egan, 1998) as a remedy to its endemic problems. Since then government, through its client and regulatory role, has further driven the industry to achieve greater efficiency through the uptake of benchmarking (Strategic Forum, 1998). Again, recently the construction industry has been specifically challenged to reduce construction costs for government contracts by 15 – 20% by 2015, from the baseline of 2012 (Cabinet Office, 2011). At a time of rising costs and the continuing financial crisis the cumulative saving required on construction cost is greater than 15 – 20%. Building Information Modeling (BIM) is being proposed as a solution to this, which enhances information sharing and collaboration across multiple firms in construction projects (Succar, 2009). BIM is seen to have the potential to improve productivity through efficiency gains (Cabinet Office, 2011) achieved through new modeling techniques that allow centralization of design information and improved communication through a central hub. The search for opportunities for productivity improvement through BIM is therefore of great concern to the industry.

Literature review

The adoption of BIM in the construction industry is seen as a journey through four levels of 'maturity' from two dimensional design practices at level 0, to fully integrated three dimensional modeling of design, time and cost at level 3 and the UK government requires all public projects to be delivered to level 2 by 2016 (BIS, 2011). Level 2 requires project teams to be working collaboratively in 3D modeling of design. Many subcontractors have design input and the concept of collaboration in design is therefore intertwined with the main contractors' supply chain. In addition, Tier 2 (subcontractor) firms generate 80% of the production costs of UK buildings, therefore for BIM to be successful in reducing costs it needs to involve tier 2 subcontractors.

The technological certainty of BIM camouflages the essential vagueness of BIM's aim to achieve efficiencies through collaboration. BIM is perhaps better understood in the same way that Childerhouse (2003) argued that

Supply Chain Management (SCM) is best understood, namely as a sub-theme within a broader discourse that promotes 'new ways of working' to the construction industry from other sectors. When promoting initiatives from one sector to another, differences in the operating environment between sectors will have an impact. Green *et al* (2005) argued that the construction industry tends to introduce 'new ways of working' from other sectors at project level without any critical appraisal of the impact of the contextual differences (structural characteristics, differing relationships with government and relative degrees of global consolidation) that shape the 'new ways of working' in different sectors.

Understanding the particular context of the construction industry was spearheaded by Lansley (1987) who recognized that construction firms need to be able to respond to changing environments due to the boom and bust, cyclical nature of demand in the construction market and also Cannon and Hillebrant (1990) who recognized that construction firms often develop strategies organically in order to cope with the uncertainty inherent in temporary, short term relationships that result from this ever changing environment. These works remain seminal and the construction industry is still characterized by localized, temporary supply chains producing a one-off product for many clients. The construction supply chain is made up of tier 1 firms (main contractors, also known as general contractors) and tier 2 firms (subcontractors, also known as specialist or trade contractors or manufacturers who have a direct contractual relationship with the main contractor). Tier 2 and tier 3 of the construction supply chain is typified by fragmentation into a large number of small, labor intensive companies and business relationships typified by competition and an adversarial inter-organisational culture.

The achievement of collaboration through BIM faces the same challenges that have faced previous SCM initiatives involving 'new ways of working' that have been imported from other sectors at a project level, with an operational perspective. These include constructability with its focus on designing for assembly (O'Connor *et al.*, 1987); lean production with its focus on identifying value, eliminating waste and the smooth flow of information and activities (Ohno, 1998); agile construction with its focus on increased flexibility and responsiveness in project based work to reduce the risks associated with complexity (Christopher and Towill, 1983); and partnering that advocates greater interdependence between firms (Latham, 1994) however in practice is primarily operational, project based change. In these four initiatives the structure of inter-organizational networks remains unchanged (Green, Fernie *et al.*, 2005). A common argument is that better collaboration is difficult to achieve through these initiatives because the construction sector is so fragmented with low interdependency and short-term relationships between firms.

A few SCM initiatives have taken a strategic perspective in which the structure of inter-organizational networks has been consolidated from previously fragmented supply chain structures. The first of these came in the field of logistics through co-operation between suppliers and contractors for improving the total flow of materials by strategic procurement (Johnston, 1981). This was followed by co-operation in specific supply chains such as elevators (Luhtala *et al.*, 1999). A further strategic initiative that has brought change under the banner of SCM is platform assembly, which focuses on increased modularization and off-site prefabrication to decrease the impact of varying site conditions (Meyer and Lehnerd, 1997). However such strategic SCM initiatives in the construction industry that have emulated the secure, long term supply chain relationships of other industries are relatively isolated examples and Vrijhoef and Koskela (2000) concluded that such initiatives have been minimal and have had only limited impact on the traditional fragmented and adversarial structure of the construction industry. The introduction of BIM into this environment of fragmentation and inter-organizational conflict does not guarantee the desired improvement. BIM therefore needs to be able to work in a climate of fragmentation and inter-organizational conflict.

Others have taken the view that the climate of fragmentation, low interdependency and short-term relationships has resulted in positive benefits for construction companies in their adoption of dynamic practices to cope with uncertainty, which set companies in the construction industry apart from those in other industries, in their degree of flexibility to respond to changes in the environment. Cannon and Hillebrandt (1990) highlighted the fact that the nature of construction companies as labor intensive, rather than capital intensive, means that business planning is a dynamic process of matching resources to projects over time whilst ensuring a positive cash flow. Green *et al.*, (2008) concluded that the 'dynamic capabilities' employed by construction companies means that strategic decision-making is a dynamic process. The theory of dynamic capabilities views organizations as set of interdependent routines, which are flexible in order to respond to changing circumstances in accordance with feedback (Nelson and Winter, 1982). Green *et al* (2008) use Teece *et al.*'s (1997) framework of dynamic capabilities to argue that flexibility, through learning and transformation, is key to success in construction companies. In this light, better

collaboration in the supply chain through BIM needs to consider the current reality of the construction sector because that brings dynamic, flexible practices.

The use of BIM in construction projects has been discussed by many researchers (Eastman *et al.*, 2011) (Mihindu and Arayici, 2008) however, there is a scarcity of reports into supply chain and BIM in research literature (Khosrowshahi and Arayici, 2012). This motivated Willmott Dixon, a national UK main contractor, to collaborate with Open BIM Network and Birmingham City University in a survey to find out their subcontractors' views on the adoption of BIM. Construction involves supply chains that converge on the construction site. Main contractors in tier 1 of the supply chain therefore play a key role in integrating tier 2 of the supply chain in a project and in promoting the use of BIM by tier 2 subcontractors.

Methodology

The views of the supply chain members' on their adoption and use of BIM were collected by an online survey. The survey questionnaire was designed through a review of literature on BIM, discussions with the main contractor's central BIM implementation team and the Open BIM Network, and by internal discussions of academics with special interest in BIM in Birmingham City University. The survey was aimed at the tier 2 supply chain members of the main contractor. The second tier supply chain firms comprised of three different company types who are suppliers to the main contractor: supply and fix specialist contractors, manufacturers and design consultants (architects and engineer designers).

The survey went out to a total 305 directors of these companies. 177 respondents returned the completed survey, a response rate of 58%. The extracted survey findings are based on these 177 responses. The survey questionnaire was divided into four sections: (i) benefits of adopting BIM (ii) barriers to adopting BIM (iii) readiness for adopting BIM (iv) priorities for support in adopting BIM. The survey also included questions on company type and size to allow for analysis. The nature of the sample is presented in Figures 1 and 2, and findings from the survey are explained below. Only descriptive statistics were used in the analysis.

Figure 1 illustrates that 48% of respondents were sub-contractors with design input, 23% were design consultants, 16% were sub-contractors without design input and 13% were 'other'. All companies who described themselves as 'other' were manufacturers. This means that subcontractors who have design input dominate the survey.

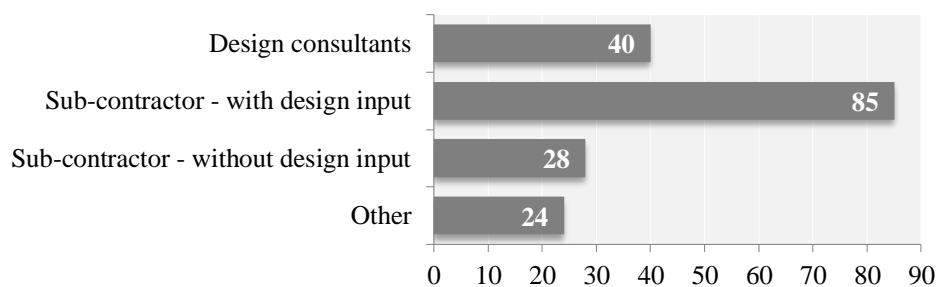


Figure 1: Responses by Company Type

Figure 2 shows that less than 5% of respondents were involved in companies of less than 10 employees. Nearly half, were involved in companies with between 10 and 50 employees, a third, 33%, were involved in companies with between 50 and 250 employees. This profile broadly reflects this highly fragmented structure of the UK construction sector, with its concentration of small firms (DTI, 2012). According to the Small Business Survey of Small and Medium Enterprises (SMEs) (i.e. companies with between 1 and 250 employees) construction sector companies tend to have fewer employees than other sectors and account for 12% of SMEs in the UK. The profile of respondents in this survey therefore broadly reflects the UK construction industry as a whole.

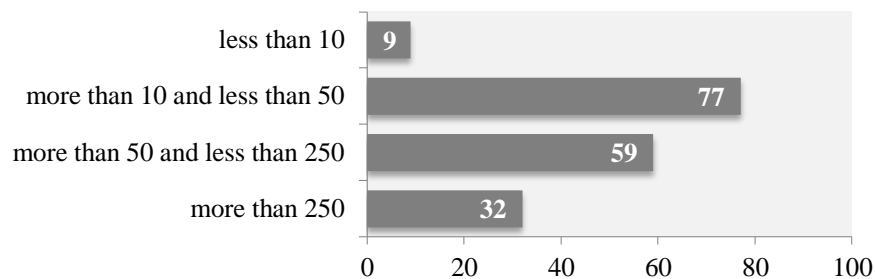


Figure 2: Responses by Company Size by Number of Employees

Results

Company Awareness and Levels of Collaboration in BIM

The survey asked respondents how they would describe their awareness of BIM. Figure 3 shows that a third of companies had already implemented BIM on projects and 38%, said their company had an early awareness of BIM. The remainder fell between these two extremes. Further analysis showed that early adoption of BIM varied significantly between company types, with design consultants nearly twice as likely to have already used BIM on projects, than sub-contractors with design input or manufacturers. No subcontractors without design input had already used BIM on projects. Company size influenced BIM awareness to a much lesser degree than company type. These survey findings reflect the early adoption of BIM amongst design consultants within the UK construction industry as a whole as BIM is step change in design information, replacing 2D drawings with data rich models (Eastman, Teicholz *et al.*, 2011).

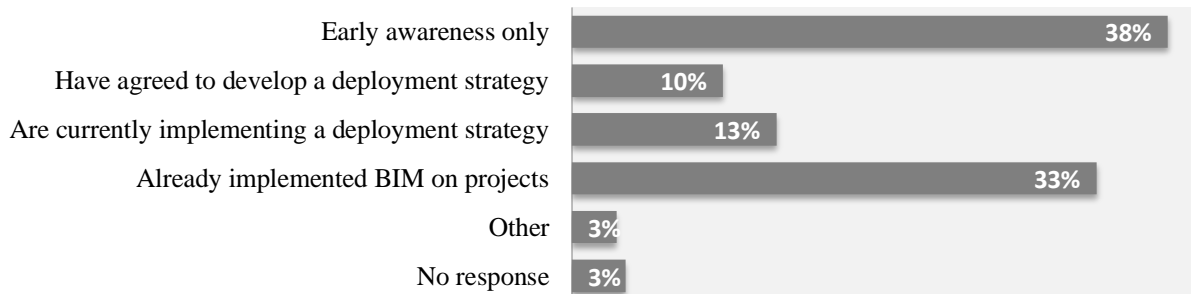


Figure 3: Companies awareness of BIM to date

Responses to questions about the level to which respondents had used BIM on projects (Figure 4) showed that a quarter of respondents had used BIM in collaboration to level 2 maturity. 13% had used BIM internally, 7% were identifying projects on which to implement BIM and 44% were not currently using BIM. Further analysis showed that level of adoption of BIM was less dependent on company size than early adoption; however company type was again a significant determining factor. Design consultants were five times more likely to have adopted BIM in collaboration to government level 2 than sub-contractors with design input and over seven times more likely than manufacturers. No subcontractors without design input had already used BIM in collaboration to government level 2 on projects. This late adoption of BIM by subcontractors with design input potentially presents a problem as Government requires all public projects to be delivered to level 2 (supplying design information across the whole supply chain) by 2016 (BIS, 2011). These results have significant implications for those second tier supply chain companies with design input.

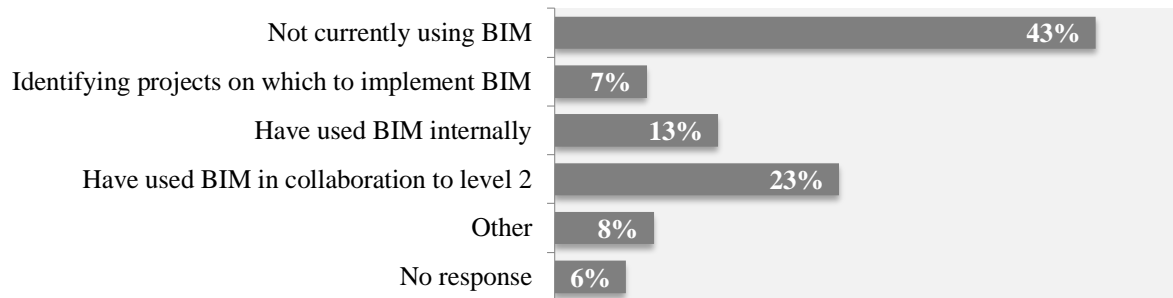


Figure 4: Companies use of BIM to date

Benefits and barriers in adopting BIM

Figure 5 shows that a clear consensus emerged amongst respondents about the issues that can potentially be overcome by the adoption of BIM in the supply chain. Respondents selected BIM's potential to (a) improve design coordination, (b) reduce risk through identifying potential problems early on, and (c) facilitate better communication of project data, as the main benefits of BIM, based on the weighting identified through the number of selections checked (but not weighted) by respondents. These priorities all concur with the aim of BIM in its widest and most ambitious sense, to enhance information sharing and collaboration across multiple firms in construction projects (Succar, 2009).

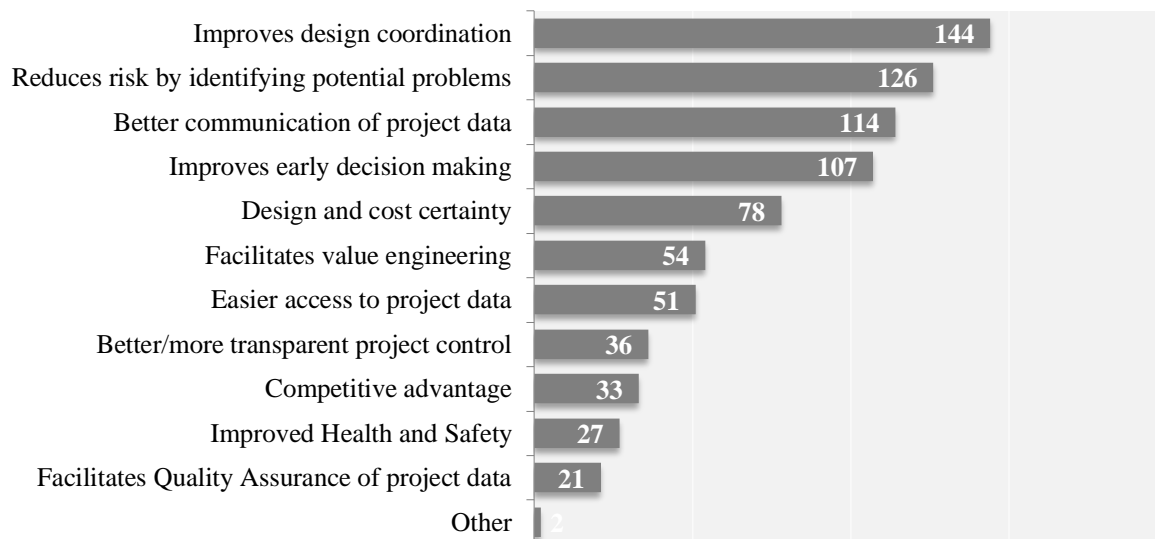


Figure 5: Companies' views on the benefits of adopting BIM

Whilst respondents priorities on the benefits of adopting BIM show a desire for greater collaboration through BIM, it is seen in Figure 6 that the primary barriers to adopting BIM in their business centered on (a) vulnerability to the weakest link (where poor performance by one of the subcontractors becomes a limiting force in a set of supply chain relationships) (b) set up costs and (c) cultural change, based on the weighting identified by the number of selections by the respondents. These identified barriers show that the respondents have a desire for construction supply chains to emulate the secure, long-term supply chains of other industries, that are conducive to investment for innovation and show high levels of trust that make them open to cultural change.

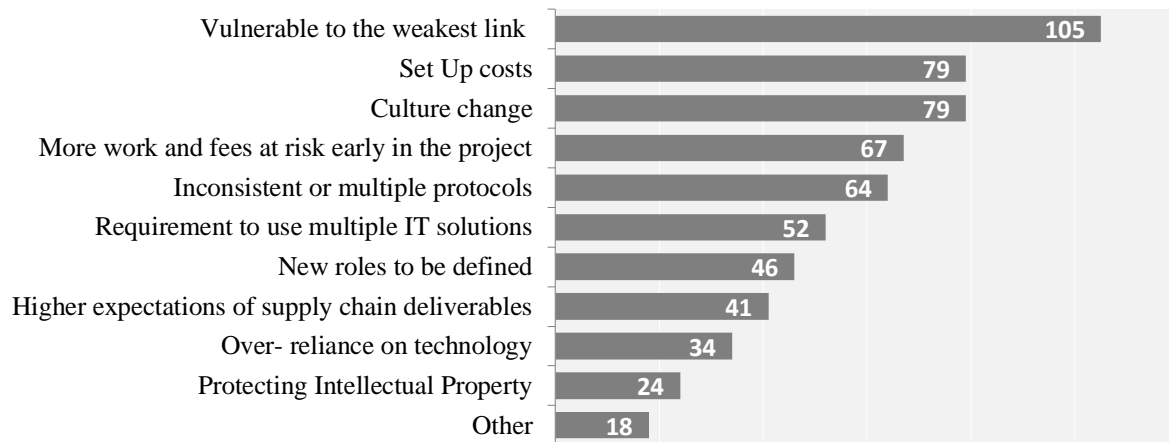


Figure 6: Companies' Views on the Barriers to Adopting BIM

Companies' priorities for support

Finally, the survey explored respondents' priorities for the type of support they would most welcome from the main contractor to help them in adopting BIM on projects. Figure 7 shows the order of supply chain members' priorities for support. It can be seen that commitment to a secure supply chain topped the list of priorities. This concurs with the finding on the barriers to adopting BIM, and shows that the respondents have a desire for construction to emulate other industries with secure, long-term supply chains. This concurs with literature on SCM that argues that collaboration is difficult to implement in construction because the industry is fragmented. Clear consistent protocols and BIM guidelines for the supply chain were second and third priorities in the list. This shows that supply chain members cannot wait for the construction industry to emulate other industries with secure, long term supply chains and are already grappling with the process changes involved in BIM within the construction industry's fragmented environment.

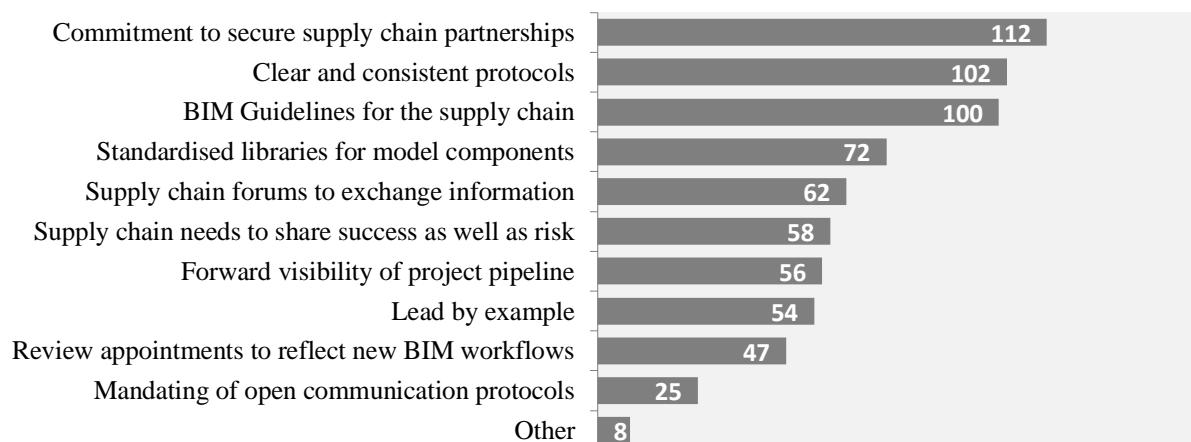


Figure 7: Priorities for Support from the Main Contractor

Discussion

It is promising that, in an industry that is traditionally locked in the mindset of competition between supply chain members, respondents views on the benefits of adopting BIM show the desire to achieve efficiencies through greater collaboration facilitated by BIM. However, the low levels of trust in the construction industry present challenges to achieving this. The findings show that the issue of trust is central to subcontractors' views on both the barriers to adopting BIM and the main priorities for support from the main contractor. Both point to a desire for collaboration

to be achieved by consolidating the structure of supply chain networks. There is a desire for strategic change in the main contractor's supply chain management from the current short-term supply chain arrangements, in which firms seek access to the supply chain on a project-by-project basis, to longer term arrangements. Subcontractors can thus be said to desire the type of stable, long-term supply chains present in other industries that share efficiency gains and provide a workplace culture of trust. But this may be unrealistic.

The literature on SCM shows that to date 'new ways of working' through SCM initiatives that have taken an operational perspective overwhelmingly outweigh strategic initiatives that result in longer-term supply chain arrangements. This leads to a question about the realism of the subcontractors' desire for the supply chains in the construction industry to emulate other industries to any significant degree. The literature on 'dynamic capabilities' that points to the positive characteristics that construction companies possess as a result of the fragmented, short term, project based nature of the industry, identifies the problem of the degree of change in operation necessary for the construction supply chain to emulate other industries' supply chain practices. There is therefore a conflict between the aspirations of the supply chain and the reality of the construction industry. This needs to be resolved before the advantages of BIM can spread down the supply chain.

Conclusion

In conclusion, the survey has provided insight into the understanding by sub-contractors that the development of collaborative working is an imperative, nonetheless an imperative that cannot be seen irrespective of context. BIM is new and rapidly developing and has the potential to deliver great benefits, but doing so requires a consideration of current ways of working which itself requires a consideration of the climate of the UK construction industry. As BIM develops it needs to accommodate these dynamic capabilities, or the industry needs to consolidate its supply chains. If the rhetoric of collaboration is imposed on the supply chain members without reference to the nature of the industry, it will struggle to deliver its potential benefits for the supply chain.

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